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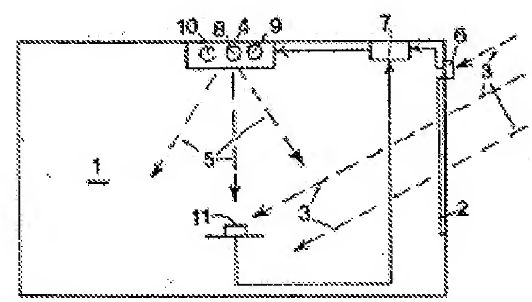
(54) Method and Arrangement for Controlling an Illumination System

(57) In an illumination system (4) in a room (1) accessible to daylight, disturbances due to the different color temperatures of the daylight (3) and of the artificial illumination (5) are avoided by measuring the color temperature of the daylight and appropriately readjusting the color temperature of the artificial illumination, for example by turning light sources (8, 9, 10) differing in color temperature on or off, by opposing bright/dark control of such light sources, it being possible to hold the total illumination level constant, or by employing light sources having controllable color temperature.



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Claims

1. Method for controlling an illumination system in a room accessible to daylight, characterized in that the color temperature of the daylight is measured and the color temperature of the light from the illumination system is regulated in dependence on the measured color temperature of the daylight.

2. Method according to Claim 1, characterized in that the color temperature of the light from the illumination system is regulated to at least approximately the color temperature of the daylight.

3. Method according to Claim 2, characterized in that the color temperature of the net illumination inside the room is additionally measured and the color temperature of the light from the illumination system is regulated in such fashion that the color temperature of the net illumination corresponds to the color temperature of the daylight.

4. Method according to one of Claims 1-3, characterized in that the daylight brightness is additionally measured and the illumination system is turned on only when the daylight brightness lies below a specified threshold.

5. Method according to one of Claims 1-3, characterized in that the illumination level inside the room is additionally measured and the brightness of the illumination system is regulated in such fashion that the measured illumination level corresponds to a specified value.

6. Arrangement for implementing the method according to one of Claims 1-5, having at least one light source (4, 8, 9, 10), an illumination measuring device (6), and a regulating device (7) driven thereby, which controls at least one operating parameter of the light source(s) in dependence on the measured illumination values, characterized in that the illumination measuring device (6) is designed as a color-temperature measuring device and is arranged so that it can measure the color temperature of the daylight (3) outside, and in that the regulating device (7) is designed so as to control the color temperature of the light (5) from the illumination system

(4) in dependence on the values measured by the color-temperature measuring device (6).

7. Arrangement according to Claim 6, characterized in that the illumination system (4) has at least two light sources (8, 9, 10) differing in color temperature and in that the regulating device (7) has a threshold circuit that turns various light sources (8, 9, 10) of corresponding color temperature on and off in accordance with the color-temperature range in which the measured color temperature of the daylight lies.

8. Arrangement according to Claim 6, characterized in that the illumination system (4) has at least two light sources (G, B) differing in color temperature and in that the regulating circuit (7) has bright/dark controls with opposing senses of control for the two light sources (G, B), which bright/dark controls control the brightnesses of the light sources (G, B) in their ratio to each other in such fashion that the resultant color temperature of the light sources (G, B) corresponds at least approximately to the measured color temperature of the daylight.

9. Arrangement according to Claim 6, characterized in that the illumination system (4) has a light source (12-21) having a controllable color temperature.

10. Arrangement according to Claim 9, characterized in that the light source has a lamp (12) having a plurality of emitting regions (13-16) differing in color temperature and radiation direction, which can be oriented by a motion of the lamp in such fashion that they emit into the room (1) light (5) having the corresponding color temperature.

11. Arrangement according to Claim 10, characterized in that the emitting regions (13-16) have different phosphors differing in color temperature.

12. Arrangement according to Claim 9, characterized in that the light source (18, 19) has a filter (19) set in front of a lamp (18) and having positionally variable color transmittance, through the motion of which relative to the lamp (18) the color temperature can be varied.

13. Arrangement according to Claim 9, characterized in that the light source (20, 21) has

a filter (21) set in front of a lamp (20) and having electrically controllable color transmittance.

14. Arrangement according to one of Claims 6-13, characterized in that in the interior of the room (1) there is a further measuring device (11), which measures the color temperature of the illumination and adjusts it, via the regulating device (7), to the measured color temperature of the daylight.

15. Arrangement according to Claim 14, characterized in that the measuring device (11) additionally regulates the illumination level in the room to a specified value.

Method and Arrangement for Controlling an Illumination System

The invention relates to a method for controlling an illumination system in a room accessible to daylight as well as an arrangement for implementing the method having at least one light source, an illumination measuring device, and a regulating device driven thereby, which controls at least one operating parameter of the light source(s) in dependence on the measured illumination values.

It is already known to control the brightness of an illumination system in dependence on the daylight brightness, for example to turn on an artificial illumination when the daylight brightness, or the daylight illumination level measured by a photometer, drops below a specified threshold and, conversely, turn it off as soon as sufficient daylight is again present. Here, however, no account has been taken of the color or color temperature of the illumination or of the daylight.

What is more, in the past it became usual in many places to illuminate larger rooms, for example large offices, stores, shopping centers and factory buildings, in purely artificial fashion with the exclusion of daylight. Here the color temperature of the artificial illumination was chosen so as to be regarded as wholesome or suitable for the persons active there or for the purpose in question. There was no possibility of modifying or adapting the color temperature.

It soon turned out that such permanent artificial illumination of interior rooms causes enormous and uneconomical energy consumption, above all when the illumination level was brought up to the recommended higher values, for example 1000 lux. Because all light sources employed for interior illumination, in particular incandescent lamps but also low-pressure fluorescent lamps, also called phosphor lamps by some manufacturers, transform only a small part of the supplied energy into usable light, the remaining surplus energy in such installations must be removed again as generally unutilized waste heat by a costly, overdesigned climate control system, especially in the case of summertime temperatures.

In modern commercial and industrial buildings, it has therefore now become accepted that mixed illumination making the maximum use of daylight for interior illumination should be preferred, as it commonly is for private rooms in any case, for economy and energy-saving reasons. Because there is generally a difference in color temperature between the artificial illumination and the daylight, however, such mixed illumination is often perceived as an

unpleasant twilight, producing disturbing color shifts and colored shadows. Such illumination can be used only to a very limited degree or not at all wherever color perception or color assessment is an issue, for example in graphics shops and textile establishments.

With the aim of remedying the stated disadvantages of the prior art, it is a goal of the invention to create a method and an arrangement for controlling an illumination system wherewith color disturbances due to differences in the color temperatures of the simultaneously employed artificial and daylight illumination are avoided or eliminated.

In the method according to the invention, this goal is achieved by measuring the color temperature of the daylight and regulating the color temperature of the light from the illumination system in dependence on the measured color temperature of the daylight.

The arrangement according to the invention is characterized in that the illumination measuring device is designed as a color-temperature measuring device and is arranged in such fashion that it can measure the color temperature of the daylight outside, and in that the regulating device is designed so as to control the color temperature of the illumination system in dependence on the values measured by the color-temperature measuring device.

Here the color temperature of the illumination system can be controlled with light sources having electrically controllable color temperature, for example through the use of lamps having controllable color temperature, or having controllable color filters, that is, filters having controllable color temperature, in front thereof.

The light sources can, however, also have a plurality of lamps differing in light color, which can be turned on or off in stepwise fashion in accordance with the measured color temperature of the daylight, or which are regulated in opposing fashion with suitable bright/dark controls.

Inside the room there can advantageously be a further illumination measuring device, which measures the color temperature of the net illumination and automatically adjusts the color temperature of the light source(s) to the color temperature of the daylight. At the same time, the illumination level in the room can be regulated to a specified value therewith and the artificial illumination can be turned off if the daylight brightness is adequate. If there is no daylight, a fixed color temperature can be established.

The invention is explained with reference to the exemplary embodiments illustrated in the drawings, in which:

Figure 1 shows a room with an illumination system and illumination measuring devices;

Figure 2 is a control chart for an illumination system;

Figure 3 shows a first light source having variable color temperature;

Figure 4 shows a further light source having variable color temperature; and

Figure 5 shows a light source having a filter with controllable color temperature.

Figure 1 shows a room 1 that receives daylight 3 through a window 2. On the ceiling of the room there is an illumination system 4 that additionally supplies the interior of the room with artificial light 5. Outside the room near window 2, or also inside the room but facing away from illumination system 4 and not irradiated thereby, there is arranged an illumination measuring device 6, which is designed as a color-temperature measuring device of known type and measures the color temperature of the incident daylight. In the simplest case this can be a red-sensitive and a blue-sensitive photosensor in a quotient circuit, the quotient of the sensor signals being a measure of the color temperature. As a rule, the measured color temperature of direct sunlight will lie around 6000 K, but it can rise to around 12,000 K under a cloudless blue sky. In contrast, the color temperatures of commercially available artificial light sources lie between around 3000 K for incandescent lamps and around 6000 K for daylight fluorescent lamps.

In order to avoid the difficulties and disturbances when mixed illumination made up of daylight 3 and artificial light 5 is employed in room 1, illumination system 4 is designed to be controllable as to its color temperature. The values measured by color-temperature measuring device 6 are processed via a regulating device 7, which in turn controls the color temperature of the artificial illumination in such fashion that it is more or less similar to the color temperature of the daylight.

In a very simple embodiment, illumination system 4 has at least two, also desirably a plurality of, light sources 8, 9, 10 having a different and graded color temperature, for example a warm-tone, a white, and a daylight fluorescent lamp. The regulating device then has a plurality of threshold switches, which form a plurality of color-temperature ranges and turn on one of the lamps having appropriate color temperature depending on the measured color temperature of the daylight. There can, however, be a larger number of lamps and a plurality of lamps can be turned on at each step, so that a finer gradation can be achieved and, furthermore, the total number of light sources turned on can thus be better matched to the daylight available by always operating only the number of light sources necessary in order to achieve a specified illumination level in

the interior of the room.

Instead of being controlled in stepwise fashion, the color temperature of illumination system 4 can also be controlled in continuous fashion, for example in that the illumination system has at least two light sources differing very greatly in color temperature, for example a warm-tone and a daylight fluorescent lamp or corresponding incandescent lamps, and in that regulating device 7 has bright/dark controls for both light sources with opposing senses of regulation, as illustrated in the control chart reproduced in Figure 2. If the color temperature T_f of the daylight is low, yellow warm-tone lamp G is practically the only one turned on; as the color temperature rises, blue daylight lamp B is more and more fully turned on while the yellow lamp is turned down; and when the color temperature T_f is high, blue lamp B is practically the only one still in operation. In this way the color temperature of artificial illumination 5 can be continuously adapted to that of daylight 3.

In principle, regulation can be performed solely with reference to measuring device 6, because the properties of the light sources employed and their dependence on the operating parameters are known, so that a suitable program can be prepared for the regulating device without difficulty and the design of regulating device 7 for given light sources poses no substantial problems. In order to become independent of the light sources employed, however, it is advantageous to provide a further illumination measuring device 11 at a representative spot in room 1. This can be set up to measure the color temperature of the net illumination in the interior of the room and to adjust the color temperature of illumination system 4, via regulating device 7, until the color temperature equals the daylight color temperature measured by measuring device 6. At the same time, additional measuring device 11 can be set up to measure the illumination level at the measurement location and, via regulating device 11, to regulate the brightness of the light sources in such fashion that it always remains constant. In this way both a consistent color temperature of the illumination and also a specified net illumination level are maintained even under mixed illumination and independently of the daylight intensity.

Instead of being implemented with a plurality of light sources differing in color temperature, however, the invention can also be implemented with light sources whose color temperature itself is variable and controllable.

Figure 3 shows such a light source, which is designed as fluorescent lamp 12 having films 13-16 of various phosphors running in the longitudinal direction of the lamp and lying next

to one another in the circumferential direction. These phosphors are so chosen that when excited by UV they emit light differing in color temperature, for example with graded color temperatures between 4000 and 10,000 K. The lamp or its mounts are affixed in the fixture so as to be rotatable about the lamp axis. Via a motor, the regulating device controls this rotation of the lamp about its axis, specifically in such fashion that, in dependence on the color temperature of the daylight, a corresponding phosphor stripe of the lamp always comes to lie at the bottom and gives off light of the desired color temperature through shutter 17.

Instead, as Figure 4 shows, a rigidly mounted lamp 18 having a movable filter 19 having a color transmittance that varies in the direction of motion can be present instead of a rotatable lamp. The motion of the filter brings portions differing in color before the lamp, so that the effective color temperature is controllable in this way.

Finally, as illustrated in Figure 5, a color filter 21 having electrically controllable transmittance can also be present in front of a rigidly mounted lamp 20. Through metered and controllable absorption of a suitable spectral component, the color temperature of the transmitted light can be controlled and regulated as desired.

The use of such electrochromatic filters has the advantage that no mechanically moving parts, which are subject to malfunction and wear, are employed, because the color or the spectral transmittance is controlled in purely electrical fashion. The disadvantage of a certain light loss due to a filter can be eliminated by instead employing light sources whose color or spectral distribution can be directly controlled in electrical fashion. Suitable light sources of this kind are for example discharge tubes having at least two ionizable gases that differ in their discharge spectra and can be excited into gas discharge by different current modes. Metal-vapor lamps having at least two distinct metals differing in vaporization temperature can also be useful if the coldest point of the lamp bulb can be brought to different temperatures by electrical heating or cooling, so that at the various temperatures metal vapors differing in composition and correspondingly differing in spectrum, that is, differing in color, are present in the gas discharge space. Electroluminescent light sources having electrically controllable color or other suitable light sources can also be employed.

The method according to the invention as described can be advantageously used wherever there is a question of exact color rendering and color recognition. The arrangement according to the invention can, however, also be used to particular advantage in dwelling spaces

in order to improve and enhance lighting comfort and thus living comfort.

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